SPERRY Microline

WATTMETER BRIDGE MODEL 123B

OPERATION & SERVICE INSTRUCTIONS

SPERRY GYROSCOPE COMPANY
DIVISION OF THE SPERRY CORPORATION
GREAT NECK, NEW YORK

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SECTION I

GENERAL DESCRIPTION

The Model 123B Wattmeter Bridge is a self-balancing, portable, direct-reading precision instrument for measuring microwave power. Highly versatile - it is designed for use with an appropriate bolometer, either barretter or thermistor, and bolometer mount for operation over frequency ranges determined by the characteristics of the accessory equipment.

In this instrument means have been provided to take into account the differences in the operating characteristics of the commonly used bolometers of either positive or negative temperature coefficient. A set of five interchangeable Microline Plug-in Units is available covering barretter operation at 200 and 125 ohms, and thermistor operation at 200, 135 and 100 ohms.

The instrument employs a modified Wien bridge circuit (see figure 1, page 17) and operates on the principle of automatic equal substitution of r-f microwave power for audio power in a bolometer inserted in one arm of the bridge. With the Model 123B Wattmeter Bridge the specific operating resistance required for matching the r-f head (bolometer and mount) to the r-f transmission line can be established and maintained continuously.

In the absence of r-f power at the bolometer the total power required to establish the specific operating resistance consists of the sum of two power components, audio and d-c, supplied by the wattmeter bridge. The audio portion is derived from a regenerative amplifier and the d-c power from a regulated supply. The amount of audio power is set to a calibration reference value by adjustment of the d-c power in the course of zero-setting the meter. The amount of d-c power supplied is determined by the kind of bolometer in use, the particular bolometer of the type chosen, the r-f power range selected and the ambient temperature. The self-balancing action of the bridge permits control of the audio component by change in the d-c component; and at all times, whether or not the meter is zero-set, the specific resistance of the bolometer is maintained within 2% of its nominal value.

When r-f power is applied to the bolometer, the self-balancing bridge action maintains an unchanged total bolometer power, with the audio power being automatically reduced by an amount equal to the r-f power. A highly sensitive vacuum-tube voltmeter, calibrated in terms of audio power changes downward from the reference value at zero-set, indicates directly the equivalent microwave r-f power.

Precision measurements of c-w microwave signal power can be obtained with the Model 123B Bridge when connected to Sperry Microline Barretter Mounts. Measurements of average pulse power are made with the Bridge coupled to appropriate Microline Thermistor Mounts. The power indicator meter is provided with both power and DBM scales. Microwave power is indicated to an accuracy of three percent over five separate ranges of 0.1, 0.3,

1.0, 3.0 and 10 milliwatts full scale. A detent switch is employed for range selection. The maximum power range of the Bridge can be extended to 100 watts or more by the use of appropriate directional couplers.

The operating controls, all located on the front panel, are used for meter zero adjustment and for range switching. A five-foot length of shielded cable for connecting the bridge to a barretter mount or thermistor mount is supplied as accessory equipment. The instrument is enclosed in a removable metal cabinet provided with louvers for adequate ventilation.

Table I given below lists the group of Microline Bolometer Mounts and Plug-in Units available for use with the Model 123B Bridge.

TABLE I

MICROLINE BOLOMETER MOUNTS & PLUG-IN UNITS
FOR USE WITH
THE MODEL 123B WATTMETER BRIDGE

Barretter Mount Model No.	Frequency Range Mc	Wattmeter Bridge Plug-in Unit[1] Model No.
148	500-2500	123B - 125B
163	2500-2700	123B - 200B
85	2700-2900	123B - 200B
164	2900-3100	123B - 200B
285	3100-3300	123B - 200B
245	3700-4500	123B - 200B
83A	4600-5650	123B - 200B
253	5300-6600	123B - 200B
212	6000-7600	123B - 200B
313	6600-8100	123B - 200B
184	8500-9600	123B - 200B
Thermistor Mount Model No.		
423A	5000-5900	123B - 135T
219A	8200-9600	123B - 135T

- - - - - - - -

[1] Five Microline Plug-in Units are available:

Model 123B - 200B for 200-ohm barretter operation.
Model 123B - 125B for 125-ohm barretter operation.
Model 123B - 200T for 200-ohm thermistor operation.
Model 123B - 135T for 135-ohm thermistor operation.
Model 123B - 100T for 100-ohm thermistor operation.

SECTION II

OPERATION

A. GENERAL

In the method described here, measurement of microwave power is accomplished with a wattmeter - where the term is used to include the bolometer, bolometer mount and wattmeter bridge as essential components. When a range-extending device such as a directional coupler is included, it becomes part of the wattmeter and contributes to the overall accuracy. It is evident, therefore, that any consideration of the accuracy of microwave power measurement by this method is not determined solely by the calibration of the wattmeter bridge, but by the characteristics of all the components involved.

Satisfactory accuracy and operation of the wattmeter as a general assembly require that the following conditions be met:

1. The bolometer and mount together shall offer a matched termination to the r-f transmission line at the required operating frequency (see Table I, page 2).

2. The type of bolometer and its operating resistance must agree with the Plug-in Unit designations (see Table I, page 2).

3. In general, any bolometer may be used with the Model 123B Bridge and available Plug-in Units, provided the bolometer temperature coefficient is appropriate (positive for the Model 125B and 200B Units, and negative for Model 100T, 135T and 200T Units) and provided the instrument can be zero-set. See C. 5, page 5.

4. If the r-f input power to the bolometer is not known to be less than 10 mw, sufficient initial attenuation should be introduced between the signal source and the bolometer mount to prevent possible damage to the bolometer. Directional couplers or other range-extending devices must always be such as to reduce the input power at the mount to a value within the chosen operating range of the wattmeter.

5. The type of bolometer must be appropriate to the kind of power to be measured. Barretters are suitable for c-w and some modulated power. Thermistors must be used, however, if the duty cycle in pulse modulation is small and the peak power is high.

In operation the mount is attached as an r-f head terminating the transmission line. Connection between mount and Bridge is furnished by the cable supplied with the Model 123B.

If a directional coupler is used to extend the measurement range, the mount is connected to the secondary branch and the primary line should be terminated in a matched

load. When the Bridge is used under these conditions, it should be recognized that additional errors are introduced due to the initial coupler calibration error, and also to departures from normal coupling and directivity values caused by any mismatch of the load in the primary line.

Where a matching transformer is inserted between the source and the bolometer mount, it is possible for a relatively high VSWR to occur at the transformer input, which means that a good percentage of the incident power would be reflected back to the source and not reach the bolometer. Changes either in transformer adjustment or signal frequency might lower the VSWR and so allow damaging amounts of power to reach the bolometer. Therefore, changes in transformer adjustment or signal frequency should be made in small increments with frequent measurement of power level. The transformer should be placed as close as possible to the element producing the mismatch in the line. This tends to minimize the effective phase change between the transformer and the discontinuity for any changes in the source frequency.

B. FUNCTIONS OF CONTROLS

The operating controls, fittings and indicator meter are located on the front panel. The receptacle for the bolometer Plug-in Units is inside the cabinet, and accessible through the hinged cover. The panel designations and control functions are listed below:

1. Power-Range Selector - a five-position switch for changing the full-scale reading of the indicator meter to any one of five values from 0.1 to 10.0 milliwatts, or from -10 to +10 DBM and for changing zero-set power in steps.

2. Zero-Adjustment Controls - a pair of control knobs for manually adjusting the indicating meter to zero in the absence of r-f power. The lower ADJ. ZERO COARSE control is for initial rough adjustment, and the upper ADJ. ZERO FINE control is for final vernier adjustment.

3. BOLOMETER - a BNC receptacle for connection of the bolometer-mount cable.

4. Input-Power Switch - The 115 v, 60 cps line-power control. A green pilot lamp above the switch indicates power ON.

C. OPERATING PRECAUTIONS

The following cautions should be observed:

1. Avoid operating the bridge in areas of stray magnetic fields that might affect the calibration of the meter.

2. ALWAYS TURN ALL CONTROLS SLOWLY TO AVOID HARMING THE METER.

3. With the bridge turned OFF, check and, if necessary, adjust the meter for precise mechanical zero before any operation of the instrument.

4. The characteristics of the Model 821 Barretter may be permanently altered if subjected to excessive power short of burnout, making it impossible to zero-set the instrument on all ranges. Damaging power, short of burnout, is in excess of twice normal, and will not occur at ordinary room temperatures if the total barretter power does not exceed 32 mw max cw. Using the 10 mw range, approximately 25 mw cw of microwave power may be applied safely, and about 15 mw cw on the 0.1 mw range.

5. At 200 ohms the power requirements of some thermistors will be too low to permit zero-setting of the meter on the 10 mw range. They may be used on this range, however, by presetting the pointer at a convenient up-scale point on the microwave power meter. Under these conditions the r-f power readings must be corrected by subtraction of the initial displaced zero value.

6. When switching to a different range, a short wait may be necessary for thermal equilibrium to be re-established at the bolometer. It is essential to re-zero the indicator meter each time the range is changed.

7. Precautions should be taken to avoid ambient temperature changes at the bolometer while the bridge is in operation, particularly those caused by handling the bolometer mount with the bare hands. It should be emphasized that, since zero-setting must be done when the bolometer microwave power is zero, best accuracy of measurement will be obtained if the zero-setting operation is done just prior to taking measurement.

D. OPERATING PROCEDURE

I. EQUIPMENT SET-UP

1. Attach the bolometer mount to the transmission line.

2. If a barretter mount is to be used, install an appropriate barretter in the mount. If a thermistor mount is to be used, consult its operating instructions for installation and replacement requirements.

CAUTION

a. Barretters are subject to damage when handled in appreciable stray microwave fields. Spares should be stored in metal containers.

b. When seating a barretter in the mount be careful not to force it, otherwise damage to the fingers of the receptacle may result.

c. Barretters are subject to damage during handling if body static discharge currents are allowed to pass through the barretter element.

3. Insert the proper Plug-in Unit in its receptacle in the Bridge. Open cover on top of cabinet to install Unit.

4. Connect the Bridge and mount with the cable included with the Bridge.

5. Connect the Bridge to the power line.

II. STARTING PROCEDURE

(a) Turning the Unit ON

1. Turn the range switch to the 10 mw position.

2. Apply the line power by turning the ON-OFF switch to ON position. This should cause the green pilot lamp on the panel directly above the switch to become illuminated.

(b) Zero-Setting

1. Allow at least two minutes for the instrument to reach overall thermal equilibrium.

2. a. Pointer drift during warm-up is a normal behavior and is greater on the low ranges.

   b. When warm-up drift becomes negligible, use the ZERO-ADJ. controls as needed to set the pointer precisely to zero.

III. R-F POWER MEASUREMENT

1. Microwave power may now be measured by the wattmeter bridge.

NOTE

To protect the bolometer, the initial application of microwave input power should be gradual so as not to exceed the rated capacity of this sensitive element. It is also advisable to start with the 10 mw range. Once the approximate order of the power level is known, the Bridge range may be changed to a more appropriate setting, or it may be seen that a directional coupler is required. Always remove all r-f input power before changing to another Bridge range. Re-zero the instrument after each range switching.

2. Power is read directly from the meter power scale in fractions of one milliwatt on the 0.3 to 1.0 mw ranges. Appropriate scale factors must be applied on other ranges.

3. DBM is read directly from the meter DBM scale when the range switch is at the 1.0 mw position. Appropriate corrections on other range switch positions must be made using the values marked on the panel.

IV. TURNING THE UNIT OFF

1. Throw ON-OFF switch to OFF position.

CAUTION

When the bridge is shut off, the bolometer is nevertheless subject to damage from microwave power overload. Also, the match presented to the transmission line will be impaired.

SECTION III

WATTMETER BRIDGE CIRCUIT

The Model 123B Wattmeter Bridge circuit consists of three basic sections: the automatic balancing bridge with its oscillator-amplifier, a vacuum-tube voltmeter for measuring differences in power, and the power supply for the instrument. The details of these circuits are shown in Figure 1, Electrical Schematic, page 17.

The audio-frequency bridge is of the Wien type with the bolometer element located in one of the arms. In order to make the instrument suitable for use with the bolometers of both negative and positive temperature coefficients and of different operating resistances, the bridge circuit is designed as a set of Plug-in Units each corresponding to a particular bolometer and specific operating resistance.

The bridge circuit is placed in the grid circuit of V-101, the input tube of a two-stage amplifier, to form an R-C oscillator whose frequency is 10 kc. Both direct current and this 10-kc power are supplied to the bolometer element. Coarse and fine controls for adjusting the amount of d-c power in the bolometer are provided by R-116 and R-117 respectively.

As microwave power is added to the bolometer, the 10-kc power output of the oscillator is automatically reduced so that the total power dissipated in the bolometer element is a constant and the bridge is kept in balance. This self-balancing action is provided by the closed regenerative loop formed by the constant-gain 10-kc amplifier and the a-c bridge circuit containing the bolometer. The feedback voltage is an otherwise negligible bridge unbalance voltage whose frequency of oscillation is determined by the Wien bridge circuit. Under these conditions the bolometer resistance must be a unique value such that the ratio of the input to unbalance voltages of the bridge equals the amplifier gain, since the oscillator-loop gain cannot deviate from unity if continuous oscillation is to be maintained. Any change, however slight, in the d-c or microwave-power components of the mixed input to the bolometer will be reflected as an equal and opposite change in the audio component. This action occurs because for a given bolometer and a given ambient temperature, the total power required for the unique bolometer resistance is a constant; and any change tending to raise or lower the total input power tends to violate the unity loop gain relationship. As they occur, such tendencies are neutralized by opposing changes of the 10-kc component to maintain the required constant total power.

It has now been shown that for this circuit the decrease in audio power must be equal to the increase in microwave power dissipated in the bolometer element. The vacuum-tube voltmeter section measures this equivalent change in audio power as the microwave input power is introduced. The amplifier tube, V-103, amplifies the resultant 10-kc component and feeds it to a bridge-type rectifier. This rectified current is used to oppose a constant direct current flowing through the meter. When minimum rectified current is present, the meter reads full scale which corresponds to maximum microwave power. Conversely, when maximum rectified current is available, the meter reads zero - corresponding to zero microwave power. R-130 is the control for adjusting the d-c meter sensitivity,

and R-125 is a feedback control used to adjust the gain of the VTVM amplifier. Controls R-130 and R-125 are used in calibration and their settings are mutually dependent.

A crystal rectifier, part of each Plug-in Unit, is connected from the bolometer ungrounded end to an appropriate point in the regenerative amplifier circuit for the protection of the Bridge when for any reason the bolometer arm is opened while the unit is on. In normal operation the crystal has a minor influence on the circuit operation but when the bolometer arm is open a bias voltage is applied to V-101 or V-102 sufficient to prevent 10-kc oscillations. The normal meter indication is then off-scale to the right.

A similar off-scale indication is produced when the ADJ. ZERO COARSE control is turned clockwise far enough on most range-switch positions. This happens because the bolometer power requirements for the operating resistance have been met or exceeded in the form of d-c power with a consequent reduction of the 10-kc power to zero. It may be noted that an increment of d-c power influences the bolometer in exactly the same manner as does an increment of r-f power.

The power supply is of the conventional voltage-regulated type with V-107 serving as the rectifier, V-104 as the control tube, and V-106 as the series-regulating tube. R-135 is a potentiometer for adjusting the magnitude of the output voltage and V-105 is the voltage-reference tube.

SECTION IV

MAINTENANCE

A. GENERAL

The Microline Model 123B Wattmeter Bridge is a precision instrument and should therefore be handled with a reasonable amount of care to prevent possible damage to the meter. Caution should be exercised at all times to keep the bridge out of strong, stray-magnetic fields which could impair the meter calibration.

If the meter fails to indicate in the normal manner, there may be an open in the bolometer arm of the bridge circuit. When the meter fails to reach scale zero when zero-setting the instrument, it may mean that the improper Plug-in Unit has been installed. Failure to adjust for zero may also be due to altered bolometer characteristics caused by overload short of burnout. This can be detected by bolometer substitution. In rare instances the trouble is due to a defective by-pass capacitor in the bolometer mount, which may be checked for leakage or short circuit by testing with an ohmmeter.

Failure to perform the zero-setting sequence successfully may be due to other causes, but is commonly the result of an open circuit occurring in the connecting cable or bolometer. Bolometer continuity may be checked using an ohmmeter, provided the high-resistance, low-current ranges are used. It should be recognized that, since a bolometer resistance depends upon the amount of current flowing in it, an ohmmeter test will rarely indicate the nominal operating resistance.

Erratic operation may be due to poor contact between bolometer and receptacle, cable plugs and jacks, or to imperfect connections between cable conductors and plugs.

A schematic diagram of the Model 123B Wattmeter Bridge is shown in Figure 1 on page 17. The schematic includes the basic Wien bridge circuit, as well as those of the d-c power supply, bolometer bias supply, 10-kc regenerative amplifier, and a typical Plug-in Unit. The function of each tube is indicated, and reference symbols and values are given for all basic circuit components. For rapid identification each panel control is shown in a double-edged box, and all adjustment or calibration points on the chassis are indicated by a single-edged box. For maintenance purposes, Section V lists all replaceable parts with their corresponding symbols and descriptions.

B. MAINTENANCE AND CALIBRATION CHECKS

Replacement of tubes and components in the vacuum-tube voltmeter and regulated power-supply sections of the Bridge must be followed by recalibration of the Bridge in accordance with these maintenance and calibration instructions in order to assure the continuation of optimum performance from this instrument before making further r-f measurements. Exceptions to this requirement are resistors R-119 through R-122 comprising the VTVM input attenuator. No restrictions on tube or component replacement apply to the

regenerative amplifier section, exclusive of the Plug-in Unit. All replacement parts are commercially available items except where indicated by accompanying Sperry part numbers in Section V, the Table of Replaceable Parts. The auxiliary test equipment required is tabulated by test item number and description in the box below:

AUXILIARY TEST AND CALIBRATION EQUIPMENT

Item No.	Description	Item No.	Description
1.	Audio-Frequency Voltmeter, or equivalent: for measurement of 0.462 rms volts and 0.164 rms volts at 10,000 cps, ±0.5%.	5.	Decade Box: resistance, General Radio Model 602K or 602N, in parallel with a 1000 (±5%) μf capacitor, and attached to a UHF plug.
2.	D-C Voltmeter: for 240 v, ±1%.	6.	Mount Cable: BNC to UHF plugs, Part of 123B Wattmeter Bridge.
3.	Audio-Oscillator: Hewlett-Packard Model 200-D, or equivalent.	7.	Microline Plug-in Unit: Any model. Part of 123B Wattmeter Bridge.
4.	A-C Voltmeter: for 105-125 rms volts at 60 cps, ±2%.	8.	Variac: General Radio Model 200-C, or equivalent.

I. POWER-SUPPLY CALIBRATION AND TEST

It is necessary to separate the chassis from the cabinet in order to perform this operation. Removal of a pair of screws on each side of the front panel and underneath at the rear of the cabinet permits the housing to be withdrawn from the instrument.

In order to facilitate locating the chassis position of certain components noted in the following sequence, it may be pointed out that Item 7, the Microline Plug-in Unit, plugs into receptacle J-101 located just behind the panel on the outer chassis surface between the indicator meter housing and the zero-adjustment potentiometer. R-135, the plate-supply adjustment potentiometer, sets the required plate voltage for three tubes. This screw-driver adjustment is located on the outer chassis surface opposite the panel between the 5Y3GT and 6Y6G tubes.

The calibration should be performed in the following steps:

1. Connect Test Item 5 to panel BNC receptacle using Test Item 6. Set box at 210 ohms.

2. Install Test Item 7 in chassis receptacle, J-101.

3. Turn panel controls to extreme clockwise position.

4. Connect instrument to power line via Test Item 8, and adjust line voltage to 115 volts.

5. Turn on line switch, allow 5-minute warm-up.

6. Adjust chassis control, R-135, for 240 volts at pin 8 of V-106, 6Y6.

7. Check for 150 volts approximately at pin 1 or 5 of V-105, OA2.

II. INDICATOR CALIBRATION

In performing this calibration of the vacuum-tube voltmeter it is required that the instrument remain in the cabinet, and that the panel be vertical as in normal operation.

Before proceeding with this operation it should be noted that J-103, the chassis pin jack, is a BNC audio-input receptacle located on the outer chassis surface (see CALIB-10KC on chassis). Chassis controls, R-125 and R-130, are screw-driver potentiometer adjustments located on the outer chassis surface midway between the indicator meter and transformer housing (see CALIBRATION on chassis). All components mentioned in this test are accessible by opening the hinged cover on top of the Wattmeter Bridge cabinet.

The indicator calibration should be performed as follows:

1. Check the a-c input voltage with Test Item 4. If its value is not 115 volts, set it at this potential using Test Item 8 in the line.

2. Remove tube V-102, 12AU7, from its socket for the duration of this calibration.

3. Apply a 10-kc voltage of 0.164 volt to the chassis pin jack, J-103, and adjust the chassis control, R-~~125~~ 130, for meter pointer position exactly at the right end of the scale.

4. Apply a 10-kc voltage of 0.462 volt at J-103, and adjust chassis control, R-~~130~~ 125, for pointer position exactly at the left (r-f zero) end of the scale.

5. Since adjustments of R-125 and R-130 affect each other, it will be necessary to alternate the adjustments until the requirements of steps 3 and 4, above, are met.

6. Shaft locks on R-125 and R-130 should be tightened, followed by a check to be sure the settings have not been disturbed.

III. BOLOMETER OPERATING-RESISTANCE CHECK

Loss of amplifier gain due to aging of V-101 and V-102 - or deterioration of other amplifier components - may cause the bolometer to operate at a resistance outside the limits of ±2% of the nominal value, with consequent impairment to the calibration of the instrument.

The prevailing operating resistance may be checked by performing the following operations:

1. Disconnect the bolometer mount from the cable and attach Test Item 5 in its place.

2. Before turning the Bridge on, set Test Item 5 at approximately 10% above the nominal operating resistance value if a barretter Plug-in Unit is used, and approximately 10% below in the case of a thermistor Plug-in Unit.

3. With the bridge on, and the range-selector switch set at the 3 mw position adjust Test Item 5 toward the nominal bolometer resistance until the meter pointer swings to the left. Determine to the nearest 0.1 ohm the value at which the pointer swings. This value should be within ±2% of the nominal bolometer operating resistance.

SERVICE AND REPAIRS

Any servicing by the user beyond the scope of this Maintenance Section is not recommended, since it may seriously impair the accuracy of the instrument and thereby invalidate the specified performance of this Bridge. Inquiries regarding the servicing, repair or operation of any Microline Model 123B Wattmeter Bridge should be directed to Field Service Engineering Department at the Sperry Gyroscope Company, Division of The Sperry Corporation, Great Neck, New York. Do not return any unit before making this contact.

SECTION V

TABLE OF REPLACEABLE PARTS

INTRODUCTION

The following table lists the electrical parts which compose the Model 123B Microline Wattmeter Bridge.

The Reference Symbol provides the necessary cross reference between the list and the Schematic Diagram, Figure 1, page 17. The parts are designated in alphabetical and numerical order by Reference Symbol.

REPLACEABLE PARTS TABLE - MODEL 123B

PART DESIGNATION	REFERENCE SYMBOL	SPECIFICATIONS VALUE	TOLERANCE	RATING	REMARKS
Capacitor	C-xxx	µf	%	vdcw	
	C-101	.25	+30,-20	400	
	C-102	1	±10	600	
	C-103 A-B-C	3 x 10	+50,-0	450	3-section electrolytic; Cornell-Dubilier Type 11145
	C-104	150	±5	500	
	C-105	.1	+100,-20	400	
	C-106	.25	+100,-20	400	
	C-107	.25	+100,-20	400	
	C-108	.10	±10	500	
	C-109	.05	+100,-20	400	
	C-110	.05	+100,-20	400	
	C-111	510	±5	500	
	C-112	.25	+100,-20	400	
	C-113	3000	+100,-20	10	
	C-114	.25	+100,-20	400	
	C-115	.02	+100,-20	400	
	C-116	2	±10	600	
Rectifier Crystal	CR-xxx				
	CR-101	Type 1N43			
	CR-102	Type 1N43			
	CR-103	Type 1N43			
	CR-104	Type 1N43			

REPLACEABLE PARTS TABLE (Cont.)

PART DESIGNATION	REFERENCE SYMBOL	SPECIFICATIONS VALUE	TOLERANCE	RATING	REMARKS
Fuse	F-101	2A			
Lamp	I-101				
Meter	M-101				Sperry Part No. 669007
Resistor	R-xxx	ohms	%	watts	
	R-101	560,000	±5	1/2	
	R-102	1,200	±5	1	
	R-103	100,000	±5	1/2	
	R-104	20,000	±5	1	
	R-105	100,000	±5	1	
	R-106	100,000	±5	1	
	R-107	20,000	±5	1	
	R-108	200,000	±5	1	
	R-109	5,100	±5	1	
	R-110	300,000	±5	1/2	
	R-111	1 Meg	±5	1/2	
	R-112	110	±5	1	
	R-113	5,000	±10	20	Wire-wound, non-inductive
	R-114	220	±5	1	
	R-115	20,000	±1	1	Deposited carbon, variable
	R-116	35,000	±20	2	Variable
	R-117	1,000	±20	2	Variable
	R-118	7,500	±0.1	1/4	Wire-wound, non-inductive
	R-119	5,840	±0.1	1/4	Wire-wound, non-inductive
	R-120	10,380	±0.1	1/4	Wire-wound, non-inductive
	R-121	18,450	±0.1	1/4	Wire-wound, non-inductive
	R-122	32,820	±0.1	1/4	Wire-wound, non-inductive
	R-123	2,200	±5	1	
	R-124	68,000	±5	1	
	R-125	350	±10	2	Wire-wound, variable
	R-126	15,000	±5	1	
	R-127	200	±5	1	
	R-128	560,000	±5	1/2	
	R-129	42,500	±1	1	Deposited-carbon, wire-wound
	R-130	5,000	±10	2	Wire-wound, variable
	R-131	42,500	±1	1	Deposited-carbon
	R-132	9,100	±5	2	
	R-133	9,100	±5	2	

REPLACEABLE PARTS TABLE (Cont.)

DESIGNATION	REFERENCE SYMBOL	VALUE	SPECIFICATIONS TOLERANCE	SPECIFICATIONS RATING	REMARKS
Resistor (Cont.)	R-134	33,000	±5	1	
	R-135	50,000	±20	2	Variable
	R-136	33,000	±5	1	
	R-137	120,000	±5	1	
	R-138	22,000	±5	1	
	R-139	5.1 Meg	±5	1	
	R-140	22	±5	1	
	R-141	5.1 Meg	±5	1	
	R-142	1400	±5	10	Wire-wound
Transformer	T-xxx				
	T-101				New York Transformer Co., Special No. 17303
Vacuum Tube	V-xxx	Type			
	V-101	12AX7			
	V-102	12AU7			
	V-103	12AU7			
	V-104	12AX7			
Voltage Regulator	V-105	0A2			
Vacuum Tube	V-106	6Y6G			
	V-107	5Y3GT			
Cable Ass'y	W-101				Sperry Part No. 710741

SECTION VI

GENERAL SPECIFICATIONS

ELECTRICAL

Power Range	0 to 10 milliwatts average power in five ranges (0.1, 0.3, 1.0, 3.0 and 10.0 mw full scale). Power may also be read over a range of +10, -20 DBM with this instrument. Power over different ranges up to 100 watts or more may be measured by the use of supplementary Microline Directional Couplers or Attenuators.
Frequency Range	Any frequency for which bolometer mounts exist. Microline Barretter Mounts from 500 to 9600 megacycles, and thermistor mounts from 5000 to 5900 and 8200 to 9600 megacycles are available.
Bridge Accuracy	±3% of full-scale reading over any range.
Input Power	105 to 125 volts, 60 cycles, 60 watts.

PHYSICAL

Fittings	BNC panel receptacle, type UG-290/U.
Overall Size	
Width	14-1/2 inches
Depth	8-1/4 inches
Height	8 inches
Weight	17 pounds

ACCESSORIES FURNISHED

Plug-in Units	One Model 123B-200B* (for 200-ohm barretter operation).
Bolometer Cable	Five feet of shielded, single-conductor cable fitted with BNC and UHF plugs.
Vacuum Tubes	Two, 12AX7; Two, 12AU7; One, 0A2; One, 6Y6G and One, 5Y3GT.

ACCESSORIES REQUIRED

Bolometer and Mount	Applicable Microline Bolometers and Mounts as listed in Table I, page 2.
Plug-in Units	Applicable Plug-in Units as listed in Table I, page 2.

* This Plug-in Unit supplied with the Model 123B Wattmeter Bridge unless otherwise specified in the order; other Plug-in Units can be ordered separately.

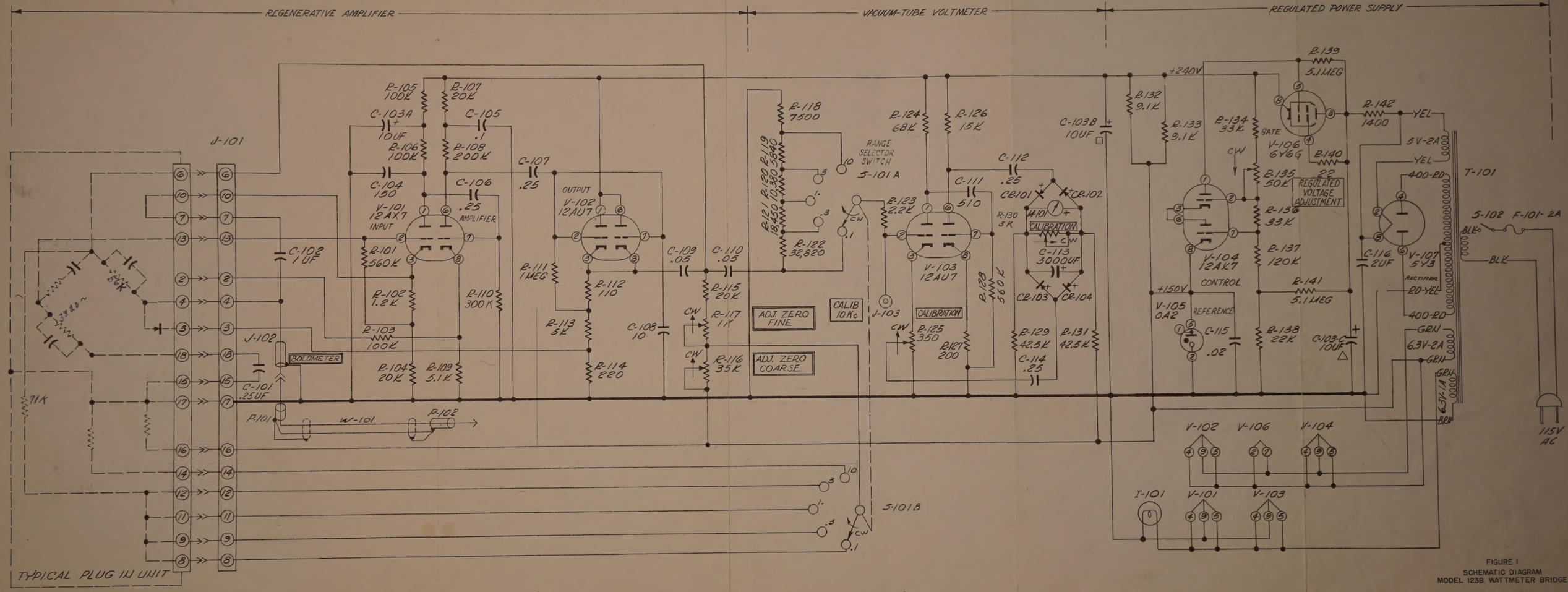

FIGURE 1
SCHEMATIC DIAGRAM
MODEL 123B WATTMETER BRIDGE